

# **Homo sapiens is the apex animal: anthropocentrism as a Dionysian sword**

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## **ABSTRACT**

Anthropocentrism, where humans are central, is a natural human viewpoint, but a threat to objective ecological study. Human population, resource use and resource expectations are expanding, turning our ecological footprint into a deep rut. We believe that, while many studies deal with the consequences of human effects on ecosystems, the outcomes are viewed as if humans were observers rather than participants in ecosystems.

Humans are the apex animal, manipulating most ecosystems with forestry, mining, agriculture, manufacturing and urbanisation: we engineer the landscape, the air, the water and even the climate. In many situations, humans are also the top predator, killing both our competitive mesopredators and their herbivorous prey. Leaving the top predator out of models reduces the alternative hypotheses and imposes directional bias on the responses of subordinate trophic levels. Our objective here is to discuss the roles of the human in the room and the consequences of ignoring them when designing experiments, proposing explanatory models and interpreting studies.

**Key words:** agri-ecosystem, apex predator, climate change, dingo, ecosystem engineer, fox, livestock, rabbit, water

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## **Introduction**

King Dionysius II and Damocles had a deal. They would switch places for a day so that the unctuous Damocles could experience the wealth, luxury and power that went with sitting on a 4<sup>th</sup> Century Sicilian tyrant's throne. However, Dionysius suspended his large sword above the throne by a single horse hair. This dampened Damocles' enthusiasm for fortune and authority; it was too much for him, so he fled.

How does this idea, which was demonstrably dangerous for Damocles, relate to anthropocentrism? By regarding and interpreting life from the viewpoint of human values and experiences, we humans place ourselves at the centre of our world. Our natural view of the world is from our perspective, where surrounding ecosystems are there to provide us with resources for consumptive and non-consumptive use. The danger in the idea comes when, through anthropocentrism, we mentally separate ourselves from nature and forget that we are biological entities. Despite broad acceptance that humans are the greatest ecosystem engineers among all animal species, zoologists and ecologists often ignore the consequences of those impacts in explanatory models for ecosystem function. We devise neat

experimental designs with some treatment sites and some nil-treatment sites, but when we come to explain the measured differences between the two, we often assume that human impacts are constant across sites. By not including humans and their effects in models, we will never gain necessary understanding about system function or have the capacity to predict the outcomes of management. Ecology is simply the study of organisms and their interactions with everything in their environment; so, studying ecology sans human impact is not really studying ecology at all. This, then, is the Dionysian sword that hangs over ecologists and land managers.

Therefore, the objectives here are fourfold. First, we outline why we ascribe apex consumer and engineer status to humans. Second, we identify the past and current roles of humans in Australian ecosystems and the possible impacts of ignoring this Dionysian sword. Thirdly, we examine the consequences of including humans in models for restorative actions. Finally, we provide direction for including human effects that might change the way studies are designed, undertaken and analysed, and the conclusions that are drawn from them.

*Homo sapiens* is the apex animal

## Welcome to the Anthropocene: humans are the apex ecosystem engineers

This is not news. In the current time, termed the “Anthropocene Epoch” (Crutzen 2006), humans have become the dominant vertebrate. To meet the needs of increasing human populations and their demands for improved standards of living, our technology is increasingly complex and dominates other species. No other animal has the same impact on ecosystems. Humans manipulate the landscape by farming, grazing, forestry, introducing invasive plants and animals, roading, urbanisation, clearing, irrigating, damming, mitigating floods, manufacturing and polluting. We have even modified the fauna and flora to our purposes through domestication. We move plants and animals about the globe, effectively joining landmasses that have been separated since the melting of the last Ice Age. If we need water, we build dams and weirs that alter stream flows and salinity levels. To cross waters and terrain that were once barriers, we build bridges and tunnels. The most insidious anthropogenic pollution is the production of greenhouse gasses, which affects climate and weather. In the Anthropocene epoch, we are no longer passengers on the earth: we are its drivers (Hobbs *et al.* 2006).

## Humans are the apex predators

Humans are the apex predator in that they fill the top trophic position (Buskirk 1999; Fleming *et al.* 2012) in most ecosystems. This is particularly so in agri-ecosystems, but also applies wherever humans kill animals for food, ecological and agricultural damage mitigation, or recreation.

As omnivores and generalist predators, humans eat seeds, grasses, herbage and fruit, and prey upon everything from insects to elephants and whales. Although smaller than much of their prey suite, humans have been able to use technology, hunting in groups, and hunting and herding aids such as horses and dogs to capture and kill large prey. The raising of livestock allows predation on a large scale and ensures continuity of food supply. By domesticating ungulates, much of the risk was removed from the hunting process. The development of traps and firearms enabled prey to be killed from a distance with little or no danger to the predator.

The best evidence that *Homo sapiens* is the apex predator is that humans have been responsible for the endangerment and extirpation of terrestrial large carnivores, mostly since the 1800s (Hayward *et al.* 2007; Woodroffe 2000; Zimmermann *et al.* 2009). This is particularly so for those with more specialised diets; for example, wolf density is negatively correlated with human density and anthropogenic loss of habitat (Linnell *et al.* 2001; Woodroffe 2000).

## A brief history of human impacts in Australia

The impacts of humans on landscapes have been through the management of fire, introduction of forage plants, weeds, ornamentals and crop plants, introduction of domesticated and other animals, introduction of novel pathogens, the harnessing and polluting of water, the ecological blitzkrieg of urbanisation, and imposition of built infrastructure for energy, transportation and extractive industries. All these have progressively changed the landscape, with the greatest impacts being since the advent of Europeans.

The underlying aridity, stochasticity of rainfall and limited distribution of permanent waters over much of the Australian continent led to the evolution of fascinating fauna able to respond to brief periods of overwhelming feast interspersed with long periods of famine. Humans have been in Australia for at least 45,000 years (Bird *et al.* 2013) and occupied most ecosystems, albeit at varying densities attributable to carrying capacity. During human occupation, there have been subtle and obvious impacts on the various ecosystems on the continent. In that time, there have also been an Ice Age and its subsequent Holocene epoch, which separated Tasmania and Kangaroo Island from the mainland about 10-12,000 years ago. Indigenous humans modified many of the ecosystems to promote year-round supplies of food (Gamage 2011). It is likely that their burning regimes prepared the way for the introduction of domestic ungulates by Europeans, with much of the landscape described as “an English nobleman’s park” (Smith 1960, p. 133-134).

Asian and European people have introduced non-indigenous animals and the first, the dingo *Canis familiaris* (see Jackson and Groves 2015), a eutherian carnivore imported from South East Asia about 4000 years ago (Corbett 2001; Oskarsson *et al.* 2012; Pang *et al.* 2009; Savolainen *et al.* 2004) that likely had major impacts on fauna (Johnson 2006). Today, dingoes and other wild dogs likely limit abundance and distribution of native fauna including macropods (Macropodidae) and emus (*Dromaius novaehollandiae*) (Choquenot and Forsyth 2013; Jonzen *et al.* 2010; Pople *et al.* 2000).

The next major anthropocentric changes began after 1788 when Anglo-Europeans constructed a penal colony at Port Jackson, and settlements in Tasmania (1803-04), Victoria (1835), South Australia (1836) and Western Australia (1826-29). European impacts accelerated with the crossing of the Blue Mountains in 1813 and a press to take agriculture to the “interior” after 1815 (Atkinson 1826). The clearing of lands to create an agricultural landscape more like England was promoted in the Colony of New South Wales, which included present-day Victoria and Queensland, and this was facilitated in the interior and north along the Great Dividing Range from Sydney

and Newcastle by deployment of convicts armed with axes. From the 1830s, livestock production expanded from Port Phillip into the Western and Wimmera Districts of Victoria, corresponding with the dispossession of the local indigenous people (Letnic 2000) and changes to fire regimes likely resulted (Gamage 2011).

The same water limitation that was the major restrictor of spatial dispersion of people likely resulted in correspondingly low dingo abundance away from the permanent water holes. Rapid uptake and spread of Australian merino sheep (*Ovis aries*) and cattle (*Bos* spp.) throughout the Western Districts of Victoria, the Murray-Darling floodplains (Williams 1962; Lunney 2001) and the downlands of southern and central Queensland (Bauer 1962) from 1830-1860, was, however, initially constrained by the distribution of permanent water. That was until the tapping of the Great Artesian Basin after the first bore was sunk near Bourke, NSW in 1878. Major earthworks and sinking of bores were necessary for livestock production in localities away from the river systems (Williams 1962). As these developments followed extirpation of dingoes in much of the semiarid rangelands, it is likely that the current density of kangaroos (*Macropus* spp.) and feral goats (*Capra hircus*) south and east of the Dingo Barrier Fence is a response to water availability more so than removal of predation. The current increasing abundance of feral goats in the Western Division of NSW (Ballard *et al.* 2011) and the independence of kangaroo densities from culling quota off-take (Lunney 2010; Wilson and Edwards 2008) show that humans are not always effective predators. These facts, and the dispersion of sheep and rabbits (*Oryctolagus cuniculus*), show that reintroduction of dingoes would be on a vastly different landscape canvas to pre-European occupation and influence (Allen 2011; Fleming *et al.* 2012).

The impact of European agriculturalists on Australian landscapes was immense and relatively sudden (Allen 2011; Lunney 2001). Negative impacts of overgrazing on grasslands were observed early (Atkinson 1926) and repeated wherever livestock and rabbits went (Butlin 1962; Williams 1962). In the Western Division of New South Wales, sheep numbers increased from 354,000 in 1860 to 13.6 million in 1891, with numbers tripling from 1879 (Butlin 1962). Between 1895 and 1904, sheep numbers crashed to 3.6 million in response to drought and overgrazing by sheep and rabbits (Butlin 1962). Likewise, but later, in the north of Australia, the sinking of bores through the 1960s and on, provided cattle with greater access to grassland ecosystems (Hunt *et al.* 2007), which were supplemented with introduced grasses and altered fire extent and intensity (Rossiter *et al.* 2003). The vegetation changes that resulted from these catastrophic anthropogenic forces persist. This is evidenced by the dramatic re-emergence of many semi arid plant species after the escape and success of rabbit haemorrhagic disease (RHD) in the late 1990s (Bird *et al.* 2012; Saunders *et al.* 2002), the increases of some small mammal

densities in northern Australian systems after removal of cattle (Legge *et al.* 2011) and, conversely, in the hotter and more widespread fire regimes of the north (Woinarski *et al.* 2004; Woinarski *et al.* 2011). The major changes to grassland ecosystems caused by livestock overgrazing may not be reversible (e.g., South Africa, Archer 2000; North America, Fleischner 1994; Tibet, Fleming *et al.* 2013) and hence need to be considered as anthropogenic drivers of faunal biodiversity change.

Permanent water is now a feature of semi-arid and arid rangelands and few places are further than 10 km from water (Fensham and Fairfax 2008; Hacker and McLeod 2003). The effect of this change on the distribution of plants and animals (Hunt *et al.* 2007) should not be undersold. Gross structural and floristic changes to vegetation form piospheres radiating from focal water points (Derry 2004; Lange 1969), with productivity and structural diversity of the vegetation and associated faunal assemblages decreasing concentrically towards the focus (but see contrary opinion in Wallach and O'Neill 2009). In Western NSW, parts of semi-arid central and southern Queensland and southern South Australia, kangaroos (particularly reds, *M. rufus*) and feral goats have benefitted from these changes (Ballard *et al.* 2011; Caughley and Grigg 1982; Caughley 1986; Caughley *et al.* 1980; Hacker and McLeod 2003) and the extirpation of dingoes and exclusion (by the Dingo Barrier Fence) associated with the introduction of sheep (Allen and West 2013).

However, the underlying conditions on either side of the Fence are also likely associated with gross differences in landuse by agricultural humans over the past 100 years. There are inherent differences in landscape productivity recognised by early administrators, such as Goyder in South Australia when determining the distribution of sheep rangelands, and more recently by Newsome *et al.* (2001). These differences have likely been exacerbated through the 100 years of different livestock enterprises and herbivore combinations, particularly by the combination of sheep and rabbits to the south and east of the Fence. The importance of overgrazing by sheep and rabbits, as causes of small mammal extinction in Western Division of NSW, are well documented (e.g. Letnic 2001; Lunney 2001; Williams *et al.* 1995). Without accounting for the underlying differences on either side of the Fence, studies (e.g., Letnic *et al.* 2009; Letnic and Koch 2010; Letnic and Dworjanyn 2011) are likely to draw erroneous conclusions about dingo effects on fox distributions. An alternative and more parsimonious explanation for higher fox density to the south and east of the Fence is that the distribution and density of foxes is more or less aligned with anthropogenic prey subsidies. This includes the Australia-wide distribution of rabbits (Saunders *et al.* 1995, West 2008), which are a primary prey of foxes in their native range (Saunders *et al.* 1995), and higher historical (Butlin 1962; Allen 2011) and current (Australian Bureau of Statistics 2009) sheep densities.

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Dams and tanks, and pasture changes with artificial fertiliser and productive introduced grasses and legumes have greatly increased the livestock stocking rates in the higher rainfall zones. Although some fauna there likely benefited from anthropogenic influences (e.g., sulphur crested cockatoos-*Cacatua galerita*, wood ducks- *Chenonetta jubata*, eastern grey kangaroos *Macropus giganteus*, brush-tailed possums *Trichosurus vulpecula*), others most definitely haven't (e.g., koalas *Phascolarctos cinereus* in NSW, Lunney *et al.* 2007 ; yellow-footed rock-wallabies *Petrogale xanthopus*, Lethbridge and Alexander 2008).

Biodiversity has decreased substantially across the wheat / sheep zones of southern and eastern Australia, where clear-felling of woodlands and forests and often laser levelling of land has preceded the planting of crops for human and livestock consumption. Human-made monocultures include grasses (wheat and sugar cane), forbs (e.g., canola and lucerne), shrubs (e.g., tea tree *Melaleuca alternifolia* and macadamia *Macadamia integrifolia*) and trees (e.g., *Pinus radiata* and *Eucalyptus globulus*), and are usually depauperate of fauna by comparison with structurally intact ecosystems (Brokerhoff *et al.* 2008).

Introduced invasive animals provided the next major anthropogenic engineering effect on Australian landscapes. Rabbits spread north and west from their introduction point in Geelong in 1859 (Coman 1999) and their rapid expansion into the semi-arid sheep rangelands was probably facilitated by the pioneering spread of sheep. Rabbits are renowned for causing vegetation change and erosion (Croft *et al.* 2002; Eldridge and Simpson 2002; Mutze *et al.* 2008). The spread of European red foxes (*Vulpes vulpes*) was likely facilitated by the prior spread of rabbits, and their current distributions are correlated (Saunders *et al.* 2010). Goats were introduced in 1788 and became feral with the failure of early angora mohair and cashmere industries in the 1830s (Evans 1980; Harrington *et al.* 1982). However, while they likely had local impact on fauna (e.g., yellow-footed rock-wallabies, Lethbridge and Alexander 2008), their numbers did not really escalate until the 1990s (Ballard *et al.* 2011) and their impacts are largely unmeasured.

Nevertheless, the combination of sheep, cattle, goats, rabbits and kangaroos, have caused gross anthropogenic engineering to semi-arid ecosystems, even affecting soil carbon and microbial activity (Holt 1997). Although RHD reduced rabbit populations over much of their distribution, grazing and browsing pressure from all large herbivores continue to restrain vegetation recovery (Denham and Auld 2004) and livestock are more likely to cause irreversible vegetation change than communities that are not anthropogenically controlled (Van De Koppel and Rietkerk 2000).

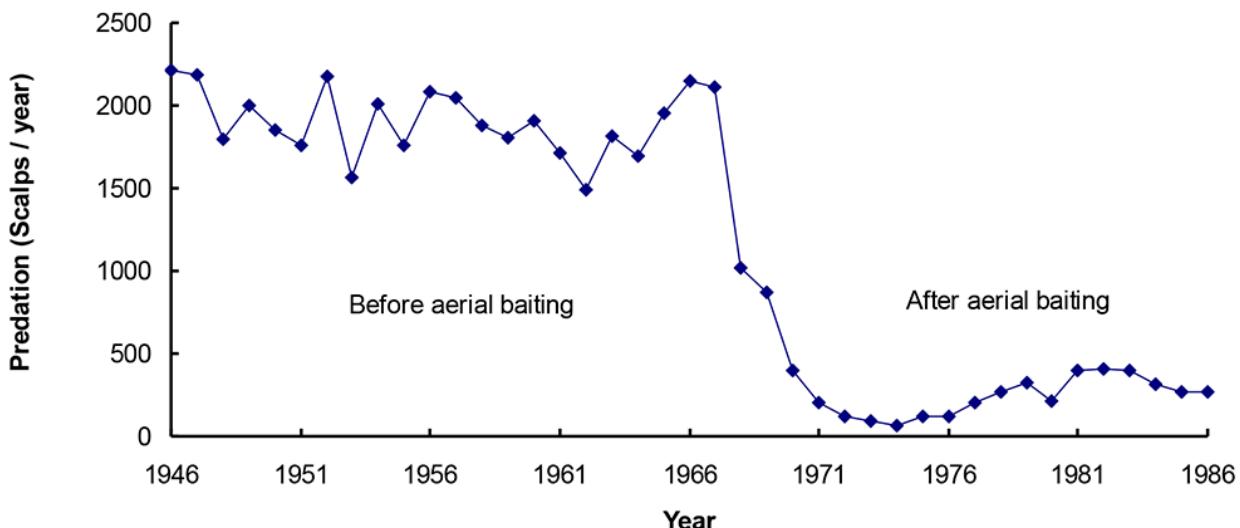
Red foxes and feral cats (*Felis catus*) are notorious examples of destructive animals purposely and accidentally released by humans (Lapidge and Henshall 2001; Meek and Triggs 1998; Abbott 2002). These predators modify faunal assemblages (Burbidge *et al.* 2009; Dickman *et al.* 2009; Read and Bowen 2001) and are linked to zoonoses and diseases affecting wildlife (Fleming *et al.* 2014; Jenkins *et al.* 2005; Saunders *et al.* 2010).

The greatest anthropogenic changes in Australia have likely occurred in the past 50 years. The human population is concentrated along the east and southern coasts of the continent and 73% live in capital cities (Australian Bureau of Statistics 2012). The population has doubled in the past 50 years (Australian Bureau of Statistics 2014) and is associated with gross landscape changes through urbanisation, industrial development, forestry, open cut mining, and intensive agricultural industries, such as market gardens, dairying and poultry production. Rapid increase in the human population and their ecological footprint has also led to fragmentation of forests and woodlands with potentially great impacts on ecosystem flux (Gill and Williams 1996).

## **Humans are the top-order predators in Australia**

Indigenous and traditional hunting (predation) on wildlife populations is practiced across the world (Redford and Sanderson 2000), as are recreational hunting and commercial hunting (e.g., kangaroos, Thomsen and Davies 2005, and deer in Australasia, Bauer and Giles 2002; Nugent and Choquenot 2004). Indigenous Australians have always been predators and their continental occupation coincided with the now-extinct megafauna for about 30,000 years (Wroe *et al.* 2004). Indigenous Australians manipulated landscapes with burning to reduce vegetation density to aid movement and hunting, and to provide grazing lawns to attract macropods (Atkinson 1826; Gamage 2011). Wombats (Vombatidae) ("its flesh is good eating being very fat", Atkinson 1826, p 25) and bilbies (*Macrotis* spp.) were dug out of burrows, and koalas ("which appear to be a delicate meat", Atkinson 1826 p25) were easily captured with throwing sticks (Moyal 2008). Since European occupation, Australians have preyed upon kangaroos, possums and koalas for their skins (Moyal 2008), and kangaroos are still hunted for consumptive use and agricultural damage mitigation (McLeod *et al.* 2004; Pople *et al.* 2010).

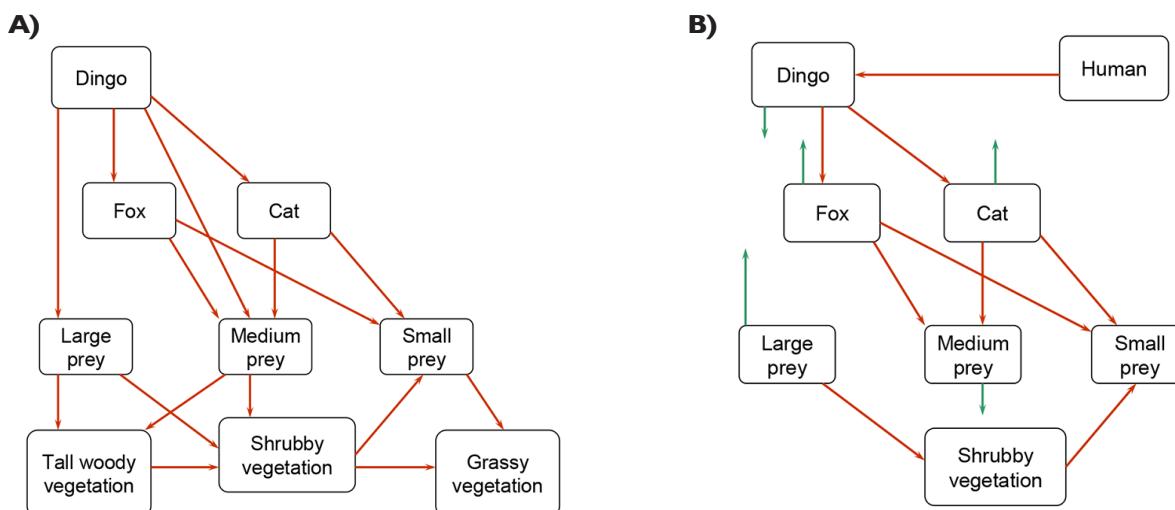
The dingo is often referred to as Australia's apex predator (e.g., Dickman *et al.* 2009; Fillios *et al.* 2010; Letnic *et al.* 2013) and there is widespread support for this concept and for meso-predator release hypothesis (e.g., Letnic *et al.* 2011; Ripple *et al.* 2014; Ritchie *et al.* 2012). However, dingoes can only be top-order predators in the absence of people. As we have stated before (Fleming *et al.* 2012),



**Fig 1** Human suppression of dingoes and other wild dogs in the North Coast and Tablelands Wild Dog Control Board district (annual number of scalps presented for bounty payment) from 1946 to 1986, when scalp bounties ceased. Before aerial baiting, control was mostly undertaken by trappers (Harden and Robertshaw 1987). Aerial baiting commenced in 1966 on the Tablelands and in 1967 on the North Coast; scalp records were cumulative over 12 months.

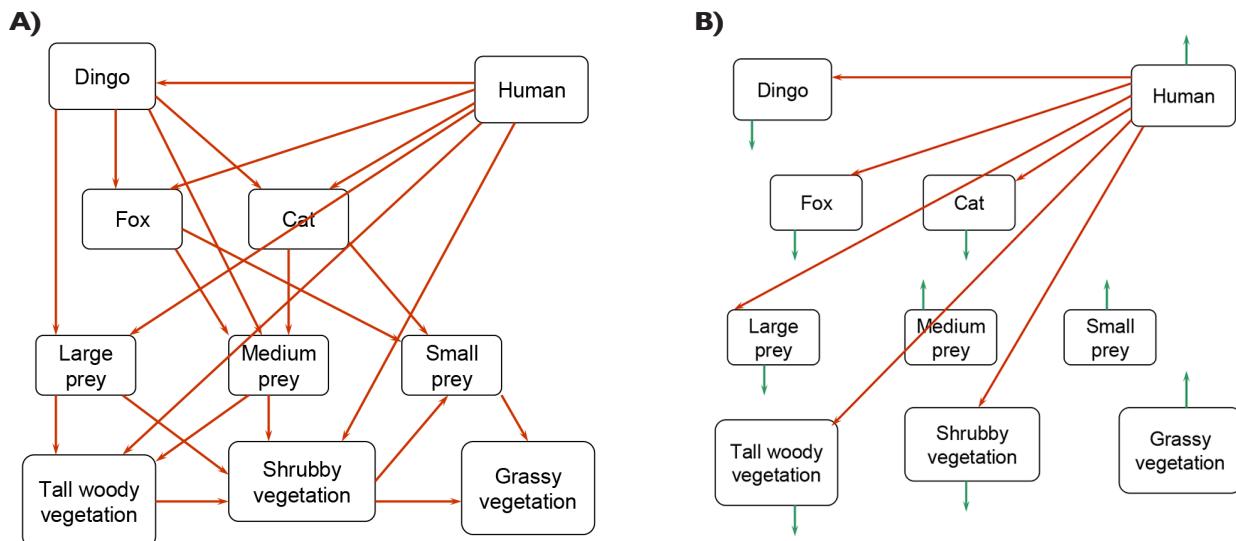
humans are the top-order predator in Australia; we regulate ungulates in the various agri-ecosystems and have facilitated the extinction of perceived competitors, such as the dingo in much of the sheep/ wheat belt of eastern Australia and the thylacine (*Thylacine cynocephalus*) in Tasmania. In other ecosystems, we have facilitated dingoes through resource subsidies including domestic ungulates (Allen and West 2013; Allen and Fleming 2004), water and rubbish (Newsome *et al.* 2013). Suppression of dingo populations by human control actions (which is functionally equivalent to predation, Caughley and Sinclair 1994) has been demonstrated (Harden and Robertshaw 1987; and Fig 1). So, dingoes and other wild

dogs are our mesopredators, which is a descriptive rather than derogatory term. We are not redefining dingoes as mesopredators because they have always filled that descriptive niche (Buskirk 1999; Fleming *et al.* 2012); they are much closer in size to mesopredator coyotes (*Canis latrans*) than grey wolves (*Canis lupus*), which are often considered apex in North American systems (e.g. Ripple *et al.* 2014), and have always been preyed upon by humans, both in their native Asia and in Australia (Corbett 2001). This is implicit in papers suggesting humans stop preying upon dingoes to release them from suppression (e.g., Colman *et al.* 2014; Wallach *et al.* 2010; Wallach *et al.* 2009): if it were not so, our control actions would not



**Fig 2.** A) A schema of possible trophic suppressive effects in Australian ecosystems ignoring humans. B) A schema of possible tri-trophic response to human predation of dingoes only. Red arrows are suppressive effects and green arrows are directions of expected population size change when suppression removed.

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**Fig 3.** A) A schema of some trophic suppressive effects including humans, showing greater complexity. B) One alternative schema of trophic responses to some anthropogenic influences, including lethal control of dingoes, foxes, cats and kangaroos, and tree and shrub clearing. Red arrows are suppressive effects and green arrows show expected direction of trophic responses.

matter. The consequence of a shift in focus to humans as apex predators is that we have multi-trophic ecosystems (e.g. Figs 2 and 3), which are not as amenable to hypothesised mesopredator release processes as tri-trophic systems (Ekerholm *et al.* 2004; Oksanen *et al.* 1981). This could partly explain why tri-trophic cascades have not been demonstrated experimentally in Australian systems (Allen *et al.* 2013a; Allen *et al.* 2013b). Mesopredator release can be observed in wild canid populations when suppression by humans is removed, and greater predation on ungulates (Fleming *et al.* 2014; Wicks and Allen 2012) and macropods (Letnic and Crowther 2013; Pople *et al.* 2000) would be expected to result. Humans are also hypercarnivores, whose surplus killing facilitates mesopredator abundance by providing waste (Newsome *et al.* 2014; Newsome *et al.* 2013).

The consequences of anthropogenically subsidised mesopredator density for smaller prey and vegetation, alluded to by Colman *et al.* (2014), are uncertain and require experimental manipulations to test the mesopredator release hypothesis and trophic cascading effects (Allen *et al.* 2013a; Ritchie *et al.* 2012). This can be done by exerting human predation on wild canids in a controlled and replicated design (e.g. Arthur *et al.* 2012) and as is being done in the biodiversity hotspot of north east NSW (Fleming *et al.* 2006; Ballard *et al.* 2014). There, the effects of human predation targeting dingoes and other wild dogs are being measured for wild dogs, red foxes, feral cats, and spotted-tailed quolls (*Dasyurus maculatus*), herbivores and vegetation.

## Restorative actions in the presence of anthropocentric humans

How, then, does this discussion influence decisions for

biodiversity conservation and restoration? Firstly, we must embrace the anthropocentric reality of our world to make a difference to it. We are not saying "like it"; we are saying, "let's acknowledge and address it explicitly". This is essentially a simple adaptive management process (e.g., Chapple *et al.* 2011; Kingsford *et al.* 2011; Walters and Holling 1990) that incorporates human dimensions during the problem definition and management action phases. People are a (the) serious problem; they must be a big part of the solution if we are to reconcile faunal biodiversity conservation with human uses of landscapes (Cullen-Unsworth *et al.* 2012; Sayer *et al.* 2013). Humans are the apex consumers of predators, prey and vegetation. Perversely, anthropocentrism leads to an unrealistic desire for people to 'step out' so that we can return systems to pristine, untouched landscapes or wilderness, as if that is some static display in a large outdoor museum. As apex consumers aiming to achieve ecological and economic sustainability, we must 'manage' to minimise and mitigate the negative impacts of our consumption; they will never be zero. Although most scientists implicitly or explicitly acknowledge the massive roles that humans play at all levels from biome to niche, it sometimes seems to us that the human element is taken as a given and then omitted from descriptive models..

Secondly, when proposing remedial actions for biodiversity conservation, we must not assume that hypotheses ignoring humans as apex consumers prevail and then promptly cease top-down forcing upon systems, as has been suggested (e.g., Ritchie *et al.* 2012; Wallach *et al.* 2010). Considering this, we revise Estes *et al.* (2011, p306) provocative statement to, "The burden of proof [should, our insertion] be shifted to show, for any ecosystem, that consumers [including humans, our insertion] do (or did) not exert strong cascading effects". When Letnic *et al.* (2013) reaffirmed the intent of Estes' original statement for Australian conditions, they presupposed that dingoes

would be able to exert the same top-down forcing on red foxes and feral cats that humans could. Anthropogenic impacts are inherently tied to conservation targets (*sensu* Hayward 2012). The importance of anthropogenic top-down forcing through predator control and fencing to enable recovery of threatened species (Hayward 2012; Hayward and Kerley 2009) is implicit in the private and private-public conservation projects, such as Australian Wildlife Conservancy (Woinarski *et al.* 2011) and Bush Heritage (Figgis *et al.* 2005) restorations.

Thirdly, immediate and delayed anthropogenic influences on biodiversity are only likely to increase along with human population size and demand for resources. Human resource needs and uses have to be incorporated in models and their testing. Future impacts caused by climate change include fragmentation and loss of montane ecosystems and some associated species, severe drying and reductions in water resources in southern Australia, increased heatwaves, fire frequency and intensity and increased damage to ecosystems through these factors (Reisinger *et al.* 2014). We argue that our chances of rejuvenating ecosystems are limited by ignoring human roles in most environments, whether they be widespread ecosystem engineering through climate change, indirect impacts by providing resource subsidies to predators and their prey, or direct impacts through predation on predators.

The importance of human activities in modifying trophic cascades has been shown (e.g., human presence affects wolf space use, with effects on elk (*Cervus elaphus*) and beaver (*Castor canadensis*) abundance in Banff National Park, Canada; Hebblewhite *et al.* 2005; and see Estes *et al.* 2011 for a good review). Trophic models that ignore historical and contemporary human influence cannot adequately describe or predict system functions and the results of such models should never be used to proscribe management actions. They're not just likely to be wrong, but are ultimately useless and possibly damaging.

Seeking to recover or reintroduce animals must be done with an explicit recognition that humans will always be in or influence the systems. Ecosystems will not be returning to a pre-European, let alone pre-human, situation anytime soon. Zoologists and ecologists should recognise that humans are important in what happens to fauna and human needs must be considered when managing to sustain fauna (Brown 2009). Restoration of faunal assemblages requires understanding of threats, which in turn requires that all the terms, including anthropogenic changes, are included in models and experiments. Otherwise, all is argument without hope of resolution and appropriate action.

## Conclusion

Humans exert great power over most, if not all, ecosystems on earth. The "Sword of Damocles is

hanging over [our] head" (O'Brien 1973), and is often used to allude to the peril, anxiety and responsibility that come with power. We have the power and responsibility to make decisions affecting ecosystems but often with insufficient or incorrect information because human impacts and history have been omitted from the models.

Ignoring human impacts (i.e., the humans in the room), that is, climate change, land and water change or degradation, or anthropogenic trophic cascades, stymies our chances of maintaining or rejuvenating ecosystems or enhancing faunal biodiversity. This must occur while ensuring human resource needs are met, including agricultural production. In our opinion, based on perusal of contemporary ecological literature, many ecologists take humans as a given cause of ecological woes, and promptly ignore their roles as apex predator and ultimate ecosystem engineers while developing their argument (e.g., Dickman *et al.* 2009; Estes *et al.* 2011; Letnic *et al.* 2013). This leads to the undertaking of research as if humans had no historical or ongoing influence on the system of interest. It should be obvious that such thinking is restrictive when developing understanding of how systems operate in the ubiquitous presence of humans. *A priori* hypotheses should allow for alternative explanations, including the history of human interventions. Where the underlying conditions differ, treatment differences may just reflect starting point differences rather than treatment effects. To test for differences the influence of season, habitat and prior management should be similar across sites.

"Essentially, all models are wrong, but some are useful" (Box and Draper 1987). We add that some models are more wrong than others and that models that omit major components are useless. We posit that there are very few places in Australia where humans have not had or are not currently having impacts on the functioning of ecosystems. By leaving historical and current human impacts (accumulated over >45,000 years and exacerbated in the past 225 years) out of the models, we cannot adequately describe or predict system functions. The consequence for conservation is that recovery actions suggested for systems where humans are ignored are more likely to be ineffective. *A priori* hypotheses should allow for alternative explanations, including the history of human interventions and the currency of human occupation and activities. Threatening processes will not be found if human effects are excluded from the models. In the Anthropocene epoch in which we live, we must take the responsibility that comes with the power at the apex; we do not have the option of fleeing.

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